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ECONOMIC CONSEQUENCES OF THE RESTRICTED USE OF ANTIBIOTICS AT SUBTHERAPEUTIC LEVELS IN BROILER AND TURKEY PRODUCTION

George Allen
and
Clark Burbee

November 1972

FARM PRODUCTION
ECONOMICS DIVISION

ECONOMIC RESEARCH SERVICE U.S. DEPARTMENT OF AGRICULTURE

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SUMMARY AND CONCLUSIONS

The Food and Drug Administration proposes to restrict the numbers of antimicrobial agents [1] used as growth promotants to those that will not create a potential human or animal health hazard. Adoption of the proposal will result in the prohibition of some antibiotics currently used in animal feeds for growth promotion, i.e. improved feed efficiency and growth rates. An investigation was made of the potential economic impact of this proposal on U.S. poultry production (broilers and turkeys) and consumers.

The investigation was conducted in two parts: (1) the potential impact with the option to use approved substitutes, and (2) the impact without any substitution possibilities. This procedure essentially establishes the upper and lower limits of the economic effects.

Under part one, numerous and effective substitution possibilities were found to exist. Besides the likelihood of several currently used antibiotics, such as bacitracin and tylosin, there are the arsenicals, nitrofurans, and organic sulfates that are generally as effective as the antimicrobial agents that may be prohibited. Furthermore, feeding of antibiotics appears to be a substitute for inadequate sanitation practices upon the part of management for unsatisfactory sanitation features in poultry housing that inhibit growth.

Statistical analyses of feed efficiency and rate of weight gain data for five antibiotics fed to broilers to market weight revealed no significant differences. The analyses of trial turkeys fed five antibiotics through eight weeks of age revealed a diff-

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[1] Antimicrobial agent for the purposes of this report is defined as any agent used in animal feeds or at clinical levels that distroy favorable pathologic bacteria media.

erence in rate of weight gain, but none in feed efficiency. It was not possible to determine whether these results would occur for turkeys fed antibiotics to market weight because of the lack of data.

Little if any economic impact will result with a shift to substitutes as long as the cost of the substitute is not appreciably different from the cost of the antibiotics that may be prohibited. Producers may be subject to some inconvenience in making the adjustment, but this should not have a significant effect on output or prices.

Under part two, three potential situations were analyzed. Two situations, A and B, assumed output was maintained at the 1970 level by (a) raising the poultry longer and (b) raising additional birds. Situation C measures the impact of reduced slaughter supplies on producers' market receipts and consumer prices with the same number of placements and length of production period as in 1970.

Broiler production costs for Situation A and B would increase by $20.6 to 26.6 million or 1.3 to 1.7 percent above the 1970 cost of $1,587 million for 10,994 million pounds. Turkey costs increase $13.0 million or 2.7 percent under "A" and $18.5 million or 3.9 percent under "B" to maintain output at 2,250 million pounds annually. (Summary Table A).

Higher mortality is a possibility under all three situations. Under Situations A and B for broilers, another 1 percent mortality,

from 3 to 4 percent, would further increase production costs by $2.5 and $5.3 million respectively. An increase in turkey mortality from 9 to 10 percent would add $1.0 and $2.2 million under the two situations.

Situation C would result in a reduction of 2.24 percent in broiler output and 3.18 percent in turkeys. Broiler production costs are reduced by $6.0 million while turkey production costs are increased by $2.8 million. With the assumption that all meat and poultry output is reduced because of the feed additive ban, the broiler receipts to producers would increase by 11.48 percent or 1.667 cents a pound (live).[2] This would increase consumer expenditures by $143.4 million on an annual basis. The turkey price would increase by 13.66 percent or 3.1 cents a pound and increase consumer annual expenditures by $51.3 million.[3]

With an additional 1 percent in mortality, the total reduction in output is 3.21 percent for broilers and 4.25 percent for turkeys. With similar reductions in output from increased mortality of beef and hogs, the total broiler price would increase by 14.40 percent or 2.092 cents a pound (live).[4] Total annual expenditures for broilers by consumers would increase by $170 million. The turkey price receipts to producers would increase by 16.86 percent or 3.81 cents a pound (live) with annual consumer expenditures increasing by a total of $60 million.[5]

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[2] Reductions in other meat quantities are: (1) beef 2.052%, (2) pork 9.428%, and turkey 3.184%.

[3] Reductions in other meat quantities are: (1) beef 2.052%, (2) pork 9.428%, and (3) broilers 2.244%.

[4] Reductions in other meat quantities are: (1) beef 2.691%, (2) pork 10.318%, and (3) turkey 4.247%.

[5] Reductions in other meat quantities are: (1) beef 2.691%, (2) pork 10.318%, and (3) broilers 3 247%.

Feed consumption under Situations A and B would increase by 236,000 tons for broilers and 195,000 tons for turkeys annually. The additional 1 point in mortality would increase the total tonnage required for broilers and turkeys to 267,000 and 206,000 tons respectively under A and B. Under Situation C, the decreased output in broilers and turkeys reduces feed tonnage for broilers by 38,000 tons and increases turkey tonnage by 72,000 tons. The additional 1 percent mortality decreases broiler feed consumption by an additional 92,000 tons and reduces turkey feed tonnage by 31,000 tons (a net increase for turkeys of 41,000 tons of feed).

With output maintained at the 1970 level, the potential impact on poultry producer costs could range between zero and $45.1 million. But considering the availability of numerous substitutes, the economic impact on producer and consumer costs is likely to be far less than the latter figure.

If producers do not have any recourse and respond by reducing output, the consequences are far more significant. Poultry producers would realize little change in total cost for a 3.99 percent reduction in poultry meat output but a substantial increase in revenue of $195 million because of higher consumer prices (Situation C). The probability of this situation ever materializing is very low.

Summary table A.--Estimated effect on producers from a total ban on use of antibiotics and substitutes at subtherapeutic levels in broiler and turkey feed rations, 1970 feed year. 1/

Item	Broilers	Turkeys	Total
	Million dollars		
Situation A: 2/			
Feed cost	16.2	12.6	28.8
Non feed cost	4.4	.4	4.8
Total	20.6	13.0	33.6
Added 1% mortality:			
Feed cost	2.5	.8	3.3
Non feed cost	---	.2	.2
Mortality added cost	2.5	1.0	3.5
Total-Situation A	23.1	14.0	37.1
Situation B: 3/			
Feed cost	16.2	12.6	28.8
Non feed cost	10.4	5.9	16.3
Total	26.6	18.5	45.1
Added 1% mortality:			
Feed cost	2.5	.8	3.3
Non feed cost	2.8	1.4	4.2
Mortality added cost	5.3	2.2	7.5
Total-Situation B	31.9	20.7	52.6
Situation C: 4/			
Feed cost	- 5.367	2.750	- 2.617
Non feed costs	- 0.625	0.045	- 0.580
Total	- 5.992	2.795	- 3.197
Added 1% mortality:			
Feed cost	- 7.283	-2.456	- 9.739
Non feed cost	- 2.260	-0.019	- 2.279
Mortality added cost	- [illegible].543	-2.475	-12.018
Total-Situation C	-1[illegible].[illegible]35	0.320	-15.215

1/ Subtherapeutic is the use of antibacterial agents at low-head or subclinical levels in feeds. Many subtherapeutic agents are used in clinical treatments for specific bacterial infections.

2/ Total of 2.999 billion broilers weighing 10.994 billion pounds; 119.681 thousand turkeys weighing 2.250 billion pounds. The same number of birds are fed a nonantibiotic feed for a longer period to achieve the same market weight as formerly.

3/ Total of 3.067 billion broilers weighing 10.994 billion pounds; 123,618 thousand turkeys weighing 2.250 billion pounds. Birds are raised the same length of time on nonadditive feed as on antibiotic additive feed.

4/ Total of 2.999 billion broilers weighing 10.748 billion pounds; 119,681 thousand turkeys weighing 2.178 billion pounds. With a 1 percent mortality, 2,969 billion broilers produce 10,637 billion pounds; 118,366 turkeys produce 2.154 billion pounds. Birds are raised on nonantibiotic feed for the same period as formerly.

Summary table B.--Estimated effect on consumers from a total ban on use of antibiotics and substitutes at subtherapeutic levels in broiler and turkey feed rations, 1970 feed year.

Item	Broilers	Turkeys	Total 1/
	Cents		
Situation A: 2/			
Annual per capita expenditure increase	10	6	16
Retail price rise per pound	.26	.72	.34
Added 1% mortality:			
Annual per capita expenditure increase	1.22	.49	1.71
Retail price rise per pound	.03	.05	.03
Situation B: 3/			
Annual per capita expenditure increase	13	9	22
Retail price rise per pound	.33	1	.45
Added 1% mortality:			
Annual per capita expenditure increase	3.00	1.00	4.00
Retail price rise per pound	.067	.20	.08
Situation C: 4/			
Annual per capita expenditure increase	71.0	25.2	96.2
Retail price rise per pound	2.28	3.88	2.57
Added 1% mortality:			
Annual per capita expenditure increase	13.4	4.6	18.0
Retail price rise per pound	.58	.89	.62

1/ Retail price rise total reflects weighted average based on per capita consumption of 41.4 pounds of broiler and 8.1 pounds of turkey.
2/ op. cit. Situation A.
3/ op. cit. Situation B.
4/ op. cit. Situation C.

Summary table C.--Estimated effect on feed consumption from a total ban on use of antibiotics and substitutes at subtherapeutic levels in broiler and turkey feed rations, 1970 feed year. 1/

Situation	Poultry	Feed consumption		
		No change in mortality		Change in mortality
		With antibiotic	Without antibiotic	Without antibiotic
		Thousand of tons		
A 2/	Broilers	11,977	12,213	12,245
	Turkeys	3,682	3,877	3,888
	Total	15,659	16,090	16,133
B 3/	Broilers	11,977	12,213	12,245
	Turkeys	3,682	3,877	3,888
	Total	15,659	16,090	16,133
C 4/	Broilers	11,977	11,940	11,847
	Turkeys	3,682	3,754	3,723
	Total	15,659	15,694	15,570

1/ Data shown here vary somewhat from total tons shown in Appendix table 1 due to rounding.
2/ op. cit. Situation A.
3/ op. cit. Situation B.
4/ op. cit. Situation C.

RECOMMENDATIONS

Utilization of growth promotant feed additives is widespread throughout the U.S. livestock and poultry industries. But the benefits of these additives in terms of improved economic efficiency remain largely unknown. To date, there are serious deficiencies in the measurement of, as well as the type of technical data obtained from trials. Without adequate technical data, it is difficult to determine with any degree of accuracy the economic benefits or costs of feed additives.

Therefore, it is recommended that the Food and Drug Administration in cooperation with the Agricultural Research and Economic Research Services initate a research program to evaluate all feed additives currently approved as growth promotants to determine the following:

(1) The differences in feed efficiency (between control and additive treated animals) during production to market or slaughter weight.

(2) The differences in the growth rate between control and additive treated animals during the production period to market or slaughter weight. 1/

1/ Lehmann, Richard P., Paper delivered at Maryland Nutrition Conference for Feed Manufacturers titled, FDA's Requirement For Clearance of Proposed Feed Additives, University of Maryland, March 1972. (Deals in some detail with the need to evaluate feed additive-animal growth benefits with a coordinated, comprehensive research effort).

(3) The difference in carcass composition and quality between control and additive treated animals to ascertain whether the additive contributes to improving carcass quality and results in a higher economic value.

(4) The residue accumulation in the waste discharge of treated animals to ascertain the potential of human, animal, and environmental hazards.

(5) The residue accumulation in the carcasses of treated animals to ascertain any potential hazard of any and all parts of the animal carcass to the health of handlers and consumers.

It is further recommended that experiments be designed to determine:

(1) Animal response from various levels of additive feeding under controlled environmental conditions.

(2) Animal response under different environmental conditions.

(3) The animal response using a variety of additives singly and in combination under controlled environmental conditions.

(4) Consumer response under these situations where carcass pigmentation or tissue composition is affected by the additive.

It is recognized that such a program will be expensive and time consuming before tangible results can be obtained. However, the results should resolve many of the questions posed by agricultural producers, human and animal health researchers, environmentalists, and consumers on the use of growth promotant feed additives.

INTRODUCTION

Antibiotics have been used for several decades at therapeutic and subtherapeutic levels on poultry. Subtherapeutic feeding 2/ of antibiotics to poultry is known to promote growth with reduced nutritional intake resulting in reduced production costs and lower consumer prices. But it is still largely a matter of conjecture as to how antibiotic feeding stimulates the growth processes. Although antibiotics suppress the growth of certain microorganisms, the suppression action results in three possible effects. First, the competition for nutrients between the microorganisms and the animal is reduced. Second, the metabolic rate of the animal is indirectly reduced. Third, antibiotics substitute for sanitation practices, the lack of which inhibit growth. These effects improve the economic efficiency of livestock and poultry production and explain the widely accepted practice of subtherapeutic feeding of antibiotics.

Use of antibiotics is publicly regulated by the Food and Drug Administration (FDA) of the Department of Health, Education and Welfare under the Federal Food, Drug, and Cosmetic Act. Approval of an antibiotic for use in animal feeds or water can only be obtained from the FDA after the manufacturer has demonstrated (1) its safety to the consuming animal, (2) it produced results claimed, and (3) it will not result in harmful effects to the handlers and consumers of the animal or its food products.

2/ Subtherapeutic is the use of antibacterial agents at low-level or subclinical levels in feeds. Many subtherapeutic agents are used in clinical treatments for specific bacterial infections.

Until recently the feeding of antibiotics on a broad scale was not presumed to constitute a human health hazard. But recent research on antibiotic resistant microorganisms suggests that some strains are or are becoming increasingly resistant to antibiotics. These resistant strains can be transmitted to man or other animals and could constitute a potential health hazard to both.

In response to the potential hazard, the FDA initiated an investigation and has proposed that all antimicrobial agents used in human clinical medicine and animal feeds that fail to meet certain criteria be withdrawn from use in animal feeds before the end of 1973. 3/ This list includes the tetracyclines, streptomycin, dihydrostreptomycin, sulfonamides, and penicillins.

The FDA report alludes to a complete ban on subtherapeutic feeding of antibiotics to poultry and livestock with an extensive analysis of economic benefits attributable to antibiotic feed additives. 4/ But the investigation does not analyze the many known substitutes that provide similar beneficial results. As a consequence, the benefits reportedly attributable to antibiotic feed additives are overstated.

3/ Federal Register, Vol. 37, No. 21, Feb. 1, 1972, pp. 2444-2445.

4/ Report to the Commissioner of the Food and Drug Administration by the FDA Task Force on the use of antibiotics in animal feeds, Appendix A, U.S. Department of Health, Education and Welfare, Rockville, Maryland, Jan. 1972.

Objectives

The purpose of this report is to investigate the economic implications of the FDA proposal on broiler and turkey production. The first section is a cursory examination of substitution possibilities and the effect of their use. The second section is a reexamination of the benefits of antibiotic feeding, disregarding all substitution possibilities, to complement a report on antibiotic feeding to livestock submitted earlier. The results of the two sections establish the minimum and maximum bounds about the potential economic impact.

Growth Promotant Substitutes

Poultry producers are usually interested in producing poultry meat and eggs at costs that yield greatest net revenue. For the producer, this enables him to compete effectively against producers of other close substitute foods. For the consumer, it means an abundance of protein food at low prices over the long run. For society, it offers an opportunity to reallocate scarce resources to the production of other goods and services.

Producers are confronted with a wide choice of alternatives to improve production efficiency and these are essentially technical substitutes for one another. Since the market for poultry products is extremely competitive, producers must select that combination of resources that minimizes cost in order to obtain adequate returns and remain in business.

Advance in poultry nutrition and in particular feed additives have been a major source of economies over the last twenty years. But antibiotics are only one form of feed additive. Arsenicals, nitrofurans, and more recently organic sulfates are examples of other additives that improve biological performance. 5/

These additives are substitutes in terms of growth promotion and may be fed individually or in combination to achieve the desired results. Antibiotics in particular are a substitute for managerial practices and housing conditions. Antibiotics as additives substitute for more stringent managerial health maintenance practices as well as housing design, construction, and operation that promotes sanitation. This translates into more time for producers to produce a larger flock and less capital investment per unit of capacity.

Unfortunately, the technical substitution relationships have not been explored enough to determine specific economic benefits. Consequently, the real benefits of antibiotic feed additives to poultry producers and consumers remain largely unknown.

SUBSTITUTES FOR ANTIBIOTICS PROHIBITED IN POULTRY FEEDS

Antimicrobial Agents

Antibiotics constitute only one group of growth promotants for poultry. Within this group, there are over 1,000 identified agents,

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5/ Feeds usually contain other additives or ingredients that contain both identified and unidentified growth factors.

but only 30 are extensively used in human clinical medicine and only 14 are approved as feed additives. 6/ Antibiotics possess different characteristics upon introduction into the digestive system. For example, some are absorbed into the circulatory system while others are not. Both types are used as feed additives and stimulate growth.

Considering the large number of identified antimicrobial agents and the continuing large scale research program to develop, test, produce, and market new as well as known antibiotics, there is little reason to doubt that one or more of the approved and several identified agents will receive FDA clearance as feed additives under the proposed criteria.

Two antibiotics that are likely to be reapproved as feed additives are bacitracin and tylosin. Bacitracin in several different forms is already widely used in poultry feeding as well as in livestock feeding programs. Tylosin is not as widely accepted for use in poultry feeds. If either one or both are near perfect substitutes for those antibiotics that are prohibited as feed additives, the economic impact on poultry production and prices will be negligible.

In order to compare the efficacy of several antibiotics (bacitracin, tylosin, penicillin, tetracycline, chlortetracycline, and erythromycin), performance data on broiler and turkey production were analyzed.

6/ M. L. Potter, "Future Use of Antibiotics in Poultry Feeds", Feedstuffs, Vol. 43, No. 34, Aug. , 1971.

The data consisted of feed conversion and weight gains on control and treated groups fed different dosages of the several antibiotics. The data were obtained from the FDA report and Dr. L. M. Potter of Virginia Polytechnical Institute. 7/

The statistical analyses on broiler performance consist of a comparison of results from trials utilizing bacitracin, tylosin, oxytetracycline, penicillin and chlortetracycline. Two analyses were made to determine whether the efficacy of bacitracin and tylosin is the same as the other three agents in terms of weight gain and feed conversion of broilers raised to market weight.

The analysis indicates no significant difference between the five antibiotics in promoting growth of broilers (Table 1). Bacitracin and tylosin are therefore satisfactory substitutes for any one of the other antibiotics.

Table 2 is an analysis of variance of the gains in feed efficiency attributable to antibiotics. The analysis was made on data for the same five antibiotics, utilizing 66 of the 71 trials used in the above analysis.

No significant differences were found between the antibiotics in terms of the feed efficiency gains attributable to the antibiotics. In conclusion, bacitracin and tylosin appear to be as effective as

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7/ Data obtained from Dr. L.M. Potter by personal correspondence.

Table 1.--Analysis of variance of weight gains attributable to antibiotics fed to broilers to market weight 1/

	BAC	PEN	OTC	CTC	TYL	Total
Sum----------	3.75	0.67	0.16	0.16	0.36	5.11
Number-------	39	16	2	3	11	71
Mean---------	0.0962	0.0419	0.080	0.0533	0.0327	
Sum of squares-----	0.5983	0.1221	0.0146	0.0194	0.0772	0.8333
Correction term--------	0.3678					

BAC = Bacitracin OTC = Oxytetracycline TYL = Tylosin
PEN = Penicillin CTC = Chlortetracycline

Source of variance	Degrees of freedom	Sum of squares	Mean square
Total--------	70	0.4643	
Antibiotics--	4	0.0555	0.0139
Individuals--	66	0.4088	0.0062

$F = 2.242$ d.f. = 4, 66 $F_{.05} - 2.51$

1/ Data source: Report to the Commissioner of the Food and Drug Administration by the FDA task force on the use of antibiotics in animal feeds, Appendix A, U.S. Dept. of Health, Education and Welfare, Rockville, Maryland, Jan. 1972.

the other antibiotics. No economic losses would be expected to result from a partial ban on antibiotic feeding as long as bacitracin, tylosin, or a similarly effective compound at the same unit prices and dosages are not prohibited.

For turkeys, the FDA report contained the results of 21 trials on antibiotic feeding to market weight. Sixteen of the trials were with bacitracin, and the remainder were with penicillin. 8/ Additional trial data were obtained from Dr. M. L. Potter for 24 trials involving the feeding of five antibiotics (bacitracin, tylosin, erythromycin, penicillin, and chlortetracycline) through eight weeks of age.

A comparison of the term trials for weight gains involving bacitracin and pencillin does not reveal any significant difference between the means of the gains (Table 3). But an analysis of the Potter data for five antibiotics does reveal a difference between the mean gains at eight weeks of age (table 4). Neither bacitracin or tylosin provide the response in weight gain that is obtained from penicillin or erythromycin.

The reason for the differences in gains between antibiotics could be attributable to other factors such as differences in antibiotic dosage and potency or environmental factors. But it is known that

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8/ U.S. Dept. of Health, Education and Welfare, op. cit., Appendix A, pp. 31.

Table 2.--Analysis of variance of gains in feed efficiency attributable to five antibiotics fed to broilers to market weight

	BAC	PEN	OTC	CTC	TYL	Total
Sum	1.63	0.53	0.09	0.06	0.52	2.83
Number	35	16	2	2	11	66
Mean	0.0466	0.0332	0.0450	0.030	0.0473	
Sum of squares	0.1781	0.0471	0.0053	0.0020	0.0348	0.2673
Correction term	0.1213					

BAC = Bacitracin OTC = Oxytetracycline TYL = Tylosin
PEN= Penicillin CTC = Chlortetracycline

Source of variance	Degrees of freedom	Sum of squares	Mean square
Total	65	0.1460	
Antibiotic	4	0.0027	0.00068
Individuals	61	0.1433	0.00235

Table 3.--Comparison of weight gains attributable to two antibiotics fed to turkeys to market weight

Antibiotic	Number	Degrees freedom	Mean gain	Sum of squares
Bacitracin-------	16	15	.43	5.95
Pencillin--------	5	4	.68	2.90
		19	Diff. .25	Sum 8.85

t = .25/.35 = .714 d.f. = 19 $t_{.05}$ = 2.093

Table 4.--Analysis of weight gains attributable to five antibiotics fed to turkeys for the first eight weeks of age

	BAC	ERY	CTC	PEN	TYL	Total
Sum----------	727	985	178	286	80	2,256
Number-------	10	8	2	2	2	24
Mean---------	72.70	123.13	89.00	143.00	40.00	
Sum of squares-----	56,753	139,331	15,874	40,906	4,882	257,746
Correction term--------	212,064					

BAC = Bacitracin CTC = Chlortetracycline TYL = Tylosin
ERY = Erythromycin PEN = Penicillin

Source of variance	Degrees of freedom	Sums of squares	Mean square
Total--------	23	45,682	
Antibiotic---	4	22,007	5,502
Individuals--	19	23,675	1,246

F = 4.416 d.f. = 4, 19 $F_{.05}$ = 2.90

body weight gains (from antibiotic supplement) during the early stages of growth are much greater than during the latter part of the growing period. Consequently, different antibiotics may result in different responses in gains early in the growing period but may not result in significant differences at market weight. In the case of turkeys, this is approximately 16 to 18 weeks for hens and 22 to 24 weeks for toms.

Since feed efficiency data for turkeys presented in the FDA report were almost entirely based on the use of bacitracin, no analysis was made.

The Potter data were analyzed for differences in feed efficiencies of eight week old turkeys fed antibiotics (Table 5). The analysis revealed no significant difference between the feed efficiency gains for the five antibiotics. Bacitracin therefore appears to be a satisfactory substitute for the other antibiotics to achieve improved efficiency in feed conversion up through eight weeks of age. Tylosin trials consisted of only two and with zero average response. The data are considered insufficient to render a valid judgement on this antibiotic.

Organic Arsenicals:

Arsenic compounds are another known feed additive that promotes growth in poultry. Either arsanilic acid or sodium arsanilate are fed to achieve improved feed efficiency and increased weight gains. However,

Table 5.--Analysis of feed efficiency gains attributable to five antibiotics fed to turkeys for the first eight weeks

	BAC	ERY	CTC	PEN	TYL	Total
Sum	0.23	0.33	0.03	0.09	0	0.68
Number	10	8	2	2	2	24
Mean	0.023	0.0413	0.015	0.045	0	
Sum of squares	0.0087	0.0165	0.0009	0.0041	0.0008	0.0310
Correction term	0.0193					

BAC = Bacitracin CTC = Chlortetracycline TYL = Tylosin
ERY = Erythromycin PEN = Penicillin

Source of variance	Degrees of freedom	Sum of squares	Mean square
Total	23	0.01170	
Antibiotic	4	0.00414	0.00104
Individuals	19	0.00856	0.00040

$F = 2.60$ d.f. = 4, 19 $F_{.05} = 2.903$

it is not known to what extent producers utilize arsenic compounds to promote growth although it is reported to be extensively used in broiler feeds. Table 6 gives a comparison of weights of four week old turkey poults fed antibiotics and arsanilic acid. The maximum level acceptable by the FDA is 90 grams of arsanilic acid per ton. Poults fed at this level attain weights similar to poults fed high levels of antibiotics, and those fed a combination of an antibiotic and arsanilic acid. In all cases, weights are much higher than the control. It is not known whether either the antibiotic-arsanilic combination or arsanilic acid additives result in statistically significant gains for turkeys at market weight.

Inorganic Sulfates:

Recent experimental work by Haims indicates that the addition of organic sulfates contributes significantly to improved feed efficiencies and increased weight gains of straight-run broilers raised to term. 9/ Apparently the sulfate substitutes for part of the methionine requirement. In a broiler feed trial, the birds receiving sodium sulfate weighed 3.147 pounds compared to 2.980 pounds for the control, an increase of 5.60 percent. Feed efficiency was 2.18 for the treatment and 2.23 for the control, an improvement of 2.24 percent.

9/ R. H. Haims, Response of Poultry to Supplemental Inorganic Sulfates, Proceedings 1972 Maryland Nutrition Conference, University of Maryland, 1972, p. 51.

Table 6.--Comparison of weights of four week old poults fed arsanilic acid and antibiotics

Additive	Grams per ton	Poult weight grams
None		357
None		382
Arsanilic acid	45	496
	68	511
	90	525
	180	535
Penicillin	1	447
	2	502
	3	529
	4	564
	5	547
Bacitracin	5	455
	10	534
Terramycin	5	465
	10	496
	15	499
	20	546
Neomycin	4	468
	20	509
Terramycin-arsanilic acid	5-90	538

Source: Frontiers in Nutrition, Supplement No. 77, Dawes Labs, Chicago, p. 277.

Housing and Management:

The response of poultry to antibiotics apparently varies with sanitation practices by management and conditions in the house. In new housing, response from antibiotic feeding is non-significant in several reported cases but is significant in old houses that are apparently harboring pathogens. The response may originate from one of two sources. A considerable amount of housing may have been constructed with sanitation features omitted by the designer. Consequently, it is not possible to thoroughly clean the buildings and equipment after an outbreak of disease or between flocks.

The second cause is lack of a sanitation program. Adequate sanitation practices are not conducted regardless of the production system design. Some of these inadequacies may consist of excessive recycling of litter, admission of disease carried on the premises by other producers, suppliers, or wildlife, or inadequate sterilization of facilities between flocks. These deficiencies can usually be readily corrected.

In conclusion, a prohibition on the use of some of the currently approved antibiotics as feed additives would not have a major economic impact on poultry production. Continued use of bacitracin and or tylosin would provide similar results in weight gain and feed conversion as other antibiotics. Furthermore, use of other feed additive compounds and improvements in management sanitation practices or housing facilities would provide similar benefits.

An economic effect would result if prices of these substitutes were substantially above corresponding prices of prohibited antibiotic additives.

ECONOMIC EFFECTS OF THE COMPLETE WITHDRAWAL OF ANTIBIOTICS IN POULTRY FEEDS FOR GROWTH PROMOTION

This section of the report examines the economic effects of a complete withdrawal of all antibiotics in poultry feeds for growth promotion without consideration for the adoption of any substitute additives or practices. Under this hypothetical program, poultry would consume more feed per pound of gain and the growth rate would be reduced. Under these circumstances, production of the same output (weight) would result in higher costs, and prices to consumers. If increased costs should reduce supply, prices would also increase. In order to examine these consequences, three situations are analyzed for broilers and turkeys. These are:

Situation A:

The same number of broilers or turkeys are fed for a longer period without antibiotics to obtain the same aggregate weight of each as reported in 1970

Situation B:

A larger number of broilers and turkeys are fed nonantibiotic feed to obtain the reported 1970 aggregate weight with the flocks grown out in the same time period as with antibiotic feed.

Situation C:

The same number of broilers and turkeys, as reported in 1970, are fed nonantibiotic feed with the flocks fed for the same length of time as occurred with antibiotic feed.

It is not certain that prohibition of subtherapeutic feeding of antibiotics would increase the incidence of mortality. However, the economic effects of an additional 1 percent increase is examined in each situation for broilers and turkeys.

Several assumptions and base data apply to the analyses for broilers and turkeys.

These are:

(1) Prior to prohibition all flocks were fed feed containing an antibiotic to promote growth.

(2) All production practices, costs, and performance results are uniform between regions.

(3) The adjustment will not affect input prices except when identified in the following text.

(4) Prohibition of subtherapeutic feeding of antibiotics will not increase pre or post mortem condemnations or alter carcass grade and quality.

(5) Expected changes in prices to consumers reflect only a approximate general equilibrium condition in the market. Since we deal with only close meat substitutes the new equilibrium so derived in only an appromination of the supply-price levels for broiler and turkeys.

(6) U.S. population was 203 million in 1970.

Broilers:

The following assumptions apply for the analysis of the three situations:

(1) Total production in 1970 was 2.999 billion birds weighing 10.994 billion pounds (live).

(2) Average market weight was 3.666 pounds in 1970 and broilers reached market weight in 58.1 days for an average daily gain of 0.0631 pounds.

(3) Average daily gain for broilers fed nonantibiotic feed is 0.0617 pounds.

(4) Feed consumption of antibiotic feed for a 3.666 pound broiler was 7.988 pounds with a conversion ratio of 2.18 (2.1789:1).

(5) Feed consumption of nonantibiotic feed for a 3.666 pound broiler is 8.145 pounds with a conversion ratio of 2.22 (2.2218:1).

(6) Mortality was 3 percent of chick placements in 1970.

(7) Broiler production costs are:

Feed with antibiotic 10/	$79.10 /ton
Feed without antibiotic 11/	78.90 /ton
Chicks	0.085/ Ea.
Contract grower 12/	0.02 / lb.
Contractor overhead	0.015/ lb.

10/ The feed cost is substantially less than the $119.27 per ton used by the FDA. The change was made following communication with Warren Trotter, Richard Russell Research Center, Athens, Georgia.

11/ Difference of 20 cents is 5 grams of antibiotic at 4 cents per gram.

12/ The grower receives 2.04 cents per pound when birds are fed feed without antibiotic and grown out a longer period to compensate for additional resource input.

Situation A:

Under Situation A, broilers are raised an additional 1.3 days to 59.4 days and fed 8.145 pounds of feed, an increase of 0.157 pounds (table 7). Feed costs per broiler increased by 0.540 cents. To compensate growers for additional resources employed, an additional 0.147 cents per bird is paid by contractors. The total increase is 0.687 cents a bird or 0.187 cents a pound.

This situation requires an additional 235,822 tons of feed at a cost of $18.606 million. 13/ With the credit for the antibiotic additive, $2.395 million for 11,977,413 tons replaced by the same amount of nonantibiotic feed, the net additional cost is $16.211 million. The nonfeed cost increase is $4.398 million, and the total annual increase in broiler production costs is $20.609 million.

Total production costs increase from $1.595 billion to $1.616 billion, an increase of 1.3 percent (table 8). On an eviscerated weight basis, 8.026 billion pounds, the cost per pound increase is 0.257 cents. 14/ With per capita consumption of 39.54 pounds annually, the increase in per capita annual expenditure is 10.15 cents.

The prohibition of subtherapeutic feeding of antibiotics could possibly result in additional mortality. Under this situation, for each one additional percentage point in mortality, it is assumed the balance of the flock is raised longer to obtain the same aggregate weight.

13/ See appendix table 1.
14/ See appendix table 2.

Table 7.--Comparison of broiler performance and costs, with and without an antibiotic feed additive, SITUATION A.

Antibiotic	Broiler weight	Gain per day	Age at term	Feed per bird		Nonfeed costs	Total cost	
				Pounds	Cents	Cents per bird	Per bird	Per pound
Grams/ton	Pounds	Pounds	Days					
5	3.666	0.0631	58.1	7.988	31.592	21.593	53.185	14.508
0	3.666	.0617	59.4	8.145	32.132	21.740	53.872	14.695
				Difference				
-5	0	-.0014	+1.3	+.157	+.540	+.147	+.687	+.187

Table 8: Total and unit broiler production costs, Situation A.

Item	Broilers fed antibiotic 1/	Broilers fed no antibiotic 1/	Four percent mortality 2/
	million		
Feed	$ 947.413	$ 963.624	$ 966.228
Chicks	262.799	262.799	262.799
Grower	219.880	224.278	224.278
Integrator	164.910	164.910	164.910
Total-------	$1,595.002	$1,615.611	$1,618.095
Per bird ---	53.184 ¢	53.872 ¢	54.516 ¢
Per lb. (live)----	14.508 ¢	14.695 ¢	14.718 ¢

1/ Total of 2.999 billion broilers weighing 10.994 billion pounds.
2/ Total of 2.9681 billion broilers weighing 10.994 billion pounds.

The increase in the mortality from 3 to 4 percent would result in a loss of an additional 30.9 million broilers with a potential market weight of 113.3 million pounds. In order to obtain the aggregate weight of 10.994 billion pounds, the remaining 2.9681 billion broilers are raised to 3.704 pounds (live). This would require raising broilers to 60.0 days of age (table 9).

Feed consumption would increase to 8.251 pounds per broiler, and the feed cost to 32.550 cents. The nonfeed cost is 21.967 cents. Total unit production cost is 54.517 cents a bird and 14.718 cents a pound. This represents an increase of 1.332 cents a bird (0.210 cents a pound) over the cost of broilers fed an antibiotic additive.

The total increase in production costs attributable to a 1% increase in mortality is for 31,474 tons of feed at a cost of $2.483 million. No change is assumed in nonfeed costs. Total production costs are $1.618 billion, an increase of 1.44 percent over the production cost with antibiotic additives and 0.15 percent over the nonadditive production cost.

The one point increase in mortality results in an additional cost increase of .032 cents per pound eviscerated and per capita annual expenditure of 1.22 cents. The total effect of a shift to nonadditive feed and the mortality increase is a cost increase of 0.288 cents a pound eviscerated and 11.4 cents per capita annually.

Under Situation A, broiler feed tonnage increased an estimated 236 thousand tons. Feed units from the nonprotein ingredient share

Table 9.--Comparison of performance and costs for broilers fed feed with and without antibiotics and experiencing different mortality levels, SITUATION A

Antibiotic	Mortality	Broiler weight	Gain per day	Age at term	Feed per bird		Nonfeed costs	Total cost	
					Pounds	Cents per bird	Cents per bird	Cents per bird	Cents per pound
Grams/ton	Percent	Pounds	Pounds	Days					
5	3	3.666	0.0631	58.1	7.988	31.592	21.593	53.185	14.508
0	4	3.704	.0617	60.0	8.251	32.550	21.967	54.517	14.718
				Difference					
-5	+1	+.038	-.0014	+1.9	+.263	+.958	+.374	+1.332	+.210

of the concentrate ration total about 171 thousand tons in corn equivalents. Feed units from protein sources in the ration--measured in soybean oil meal protein levels--total an additional 65 thousand tons. With an increase of 1 percent in mortality, there is an additional feed requirement of 31 thousand tons. This represents 22 thousand tons of feed units from nonprotein sources and 9 thousand tons from the protein share of the feed concentrate ration.

Situation B:

Under Situation B, broilers are raised to the same age, 58.1 days, but additional broilers are required to obtain the same aggregate weight, 10.994 billion pounds. Broilers raised on nonantibiotic feed to 58.1 days weigh 0.0822 pounds less at term or 3.5838 pounds compared to birds receiving antibiotic feed (table 10). In order to hold output constant, an additional 68.7 million broilers per year are required.

Each broiler consumes 7.962 pounds of feed resulting in increase of 235,822 tons, as in Situation A. Total net cost for the feed is $16.211 million, and the additional chicks cost $6.020 million. In order to attract additional production resources, all producers are paid 2.04 cents a pound. This adds another $4.398 million to production costs.

Total production costs increase by $26.629 million, or 1.67 percent over the cost of production with an additive (table 11). The

Table 10.--Comparison of performance and costs for broilers fed feed with and without antibiotic feed additive, SITUATION B

Antibiotic	Broiler weight	Gain per day	Age at term	Feed per bird		Nonfeed costs	Total cost	
				Pounds	Cents	Cents per bird	Cents per bird	Cents per pound
Grams/ton	Pounds	Pounds	Days					
5	3.666	0.0631	58.1	7.988	31.592	21.593	53.185	14.508
0	3.5838	.0617	58.1	7.962	31.412	21.450	52.862	14.750
				Difference				
-5	-.0822	-.0014	0	-.020	-.180	-.143	-.323	+.242

per bird cost is 0.323 cents less, but the per pound cost is 0.242 cents higher. On an eviscerated basis, the cost increase is 0.332 cents a pound. Per capita expenditure for broilers is 13.1 cents higher annually under this situation, 2.96 cents more than under Situation A. 15/

An increase in the mortality rate from 3 to 4 percent of placements would result in a loss of 31.626 million broilers with a potential market weight of 113.340 million pounds. Offsetting this loss would require an additional 31,477 tons of feed at a cost of $2.483 million and additional chicks at a cost of $2.800 million. Other nonfeed costs remain the same (table 11).

The total cost increase is $5.283 million. The mortality increase adds 0.172 cents to the production cost of each broiler or 0.048 cents a pound (table 11). On an eviscerated weight basis, the increase is 0.066 cents a pound, and increases in per capita expenditures amount to 2.60 cents annually.

Table 12 presents the change in inputs and costs between broilers fed feed with an antibiotic additive and broilers not receiving the additive and incurring the higher mortality rate. Broiler production costs are 0.151 cents per bird lower without the antibiotic, but the per pound cost is 0.290 cents higher. For eviscerated broilers, the

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15/ See appendix table 3.

increase is 0.397 cents a pound, and per capita expenditures are increased by 15.72 cents annually. The total increase in expenditures is $31.912 million on an annual basis.

Under Situation B with no change in mortality, the additional 236,000 tons of feed is equivalent to 171,000 tons of corn and 65,000 tons of soybean meal. With the increase in mortality the 267,000 tons of additional feed has concentrates equivalent to 193,000 tons of corn and protein equivalent to 74,000 tons of soybean meal.

Situation C:

A total of 2.999 billion broilers are raised on nonantibiotic feed to the same age, 58.1 days, as birds fed antibiotic feed. This results in an output of 10.748 billion pounds, a reduction of 246 million pounds or 2.24 percent. In terms of production costs, feed costs are reduced by $5.367 million (37,664 tons) and grower costs are $0.625 million less. Other costs remain the same.

The total reduction in costs is $5.992 million to $1,589.010 million (table 13). On a per pound basis, the live weight cost increases by 0.276 cents to 14.784 cents. The eviscerated cost increase is 0.378 cents a pound.

Table 11: Total and unit broiler production costs, situation B

Item	Broilers fed antibiotic 1/	Broilers fed no antibiotic 2/	Four percent mortality 2/
	million		
Feed	$ 947.413	$ 963.624	$ 966.107
Chicks	262.799	268.819	271.619
Grower	219.880	224.278	224.278
Integrator	164.910	164.910	164.910
Total	$1,595.002	$1,621.631	$1,626.914
Per bird	53.184 ¢	52.862 ¢	53.034 ¢
Per lb.	14.508 ¢	14.750 ¢	14.798 ¢

1/ Total of 2.999 billion broilers weighing 10.994 billion lbs.
2/ Total of 3.067 billion broilers weighing 10.994 billion lbs.

The reduction in output will affect the farm value of broilers and total revenue as well as the total expenditures of consumers. Although essentially no broilers are sold in an open market at the farm level, imputed price and total revenue values can be determined. This involves calculation of the expected broiler price change in relative terms and applying the change to a base price for broilers. The expected price change is a function of reduced outputs for substitute items: beef, pork, and turkeys, as well as broilers. The elimination of the additive and constraint on the production period reduces output for all four items.

The equation for estimating the broiler price change is:

$$\% \Delta P_c = -.483Q_b - .600Q_p - 1.859\ Q_c - .207Q_t$$

where the reduction in quantities are:

Beef $(Q_b) = -2.052\%$

Pork $(Q_p) = -9.428\%$

Broilers $(Q_c) = -2.244\%$

Turkeys $(Q_t) = -3.184\%$

The expected change in the farm value of broilers is an increase of 11.48 percent. If the cost of broilers fed antibiotic feed is assumed as the farm value, 14.508 cents a pound, the new value is 16.174 cents a pound, 1.667 cents higher. The effect on total value is an increase of $143.350 million from $1,595.002 to $1,738.352 million.

The difference between total farm value and total farm cost increases from zero to $149.342 million, the increase in farm value plus the reduction in production costs. Such a high return on broiler production would attract new resources into production and output would increase rapidly. Without any change in the quantities of the other meats, a 4.62 percent increase in broiler output would bring the farm value down to the new average cost level of 14.784 cents a pound. The industry could accomplish such an increase in output in one year if past expansion rates are any criteria.

The effect on consumer prices is an increase of 2.28 cents a pound for ice packed eviscerated broilers. With a per capita consumption of 38.65 pounds eviscerated, the per capita expenditure increase is equivalent to 70.6 cents a year.

A 1 percent increase in mortality under Situation C reduces aggregate annual output by 111 million pounds, from 10.748 to 10.637 billion. Total production costs are reduced by $9.543 million as a result of lower feed consumption and grower payments (table 13). Unit costs increase from 14.784 to 14.849 cents a pound live, or 0.065 cents. On an eviscerated basis, the increase is equivalent to 0.089 cents a pound.

The effect of an additional 1 percent increase in mortality for beef, pork, broilers, and turkeys on broiler prices is estimated by

Table 12: Comparison of performance and costs for broilers receiving feed with and without antibiotic and experiencing a higher mortality rate, Situation B.

Antibiotic grams/ton	Mortality rate percent	Broiler wt. lbs.	Gain per day lbs.	Age at term days	Feed per bird		Non feed costs	Total cost	
					lbs.	cents	Cents per bird	Cents per bird	Cents per lb.
5	3	3.666	.0631	58.1	7.988	31.592	21.593	53.185	14.508
0	4	3.5838	.0617	58.1	7.983	31.493	21.541	53.034	14.798
Difference									
-5	+1	-.0822	-.0014	0	-.005	-.099	-.052	-.151	+.290

Table 13: Total and unit broiler production costs, situation C

Item	Broilers fed antibiotic 1/	Broilers fed no antibiotic 2/	Four percent mortality 3/
	million		
Feed	$ 947.413	$ 942.046	$ 934.764
Chicks	262.799	262.799	262.799
Grower	219.880	219.255	216.995
Integrator	164.910	164.910	164.910
Total	$1,595.002	$1,589.010	$1,579.468
Per bird	53.184 ¢	52.985 ¢	53.215 ¢
Per lb.	14.508 ¢	14.784 ¢	14.849 ¢

1/ Total of 2.999 billion broilers weighing 10.994 billion pounds.
2/ Total of 2.999 billion broilers weighing 10.748 billion pounds.
3/ Total of 2.968 billion broilers weighing 10.637 billion pounds.

revising the quantity change coefficients in the above equation. The revised percentages are:

Beef (Q_b) = - 2.691%

Pork (Q_p) = - 10.318%

Broilers (Q_c) = - 3.247%

Turkeys (Q_t) = - 4.247%

With the above changes in quantities, the farm value of broilers is increased by 14.41 percent over the feed with antibiotic case, 2.93 percent more than in the feed without antibiotic and no change in mortality case. The combined effect of the weight reduction per animal and higher mortality is an increase in the farm value of broilers to 16.599 cents a pound. This is 0.425 cents a pound higher than the no change in animal mortality.

Total farm value of broilers with mortality increased is $1,765.638 million, $27.286 million more than the no change in mortality broiler farm value and $170.636 million more than the value for broilers receiving an antibiotic feed. The higher mortality rate would add $36.828 million to net farm value as a result of a higher price and reduced production cost. The combined effect of lower average weight per bird and a higher mortality is an increase in net farm value of $186.170 million or 1.75 cents a pound. This high rate of return would undoubtedly result in considerable industry expansion in output and correspondingly lower prices.

For consumers, the increase in mortality would boost per capita expenditures for broilers by 13.4 cents annually. The total increase would be $.84 annually for a per capita consumption of 38.25 pounds of eviscerated broilers. This is equivalent to 2.9 cents a pound more than would be paid for broilers receiving antibiotic feeds assuming no change in marketing margins.

Feed use in Situation C with no change in mortality is reduced 38 thousand tons reflecting the reduced output of 246 million pounds of broilers. This is equivalent to 27 thousand tons of corn and 11 thousand tons of soybean meal measured in feed units. With a 1 percent increase in mortality, feed use would decline by an additional 92 thousand tons or 67 thousand tons of feed units from the nonprotein share of the concentrate ration. An estimated 25 thousand tons of feed units from protein sources of soybean meal equivalent would also be eliminated.

In conclusion, production of the same output of broilers, 10.994 billion pounds, without antibiotics would boost production costs between $20.6 and $31.9 million depending on the Situation, A or B, and mortality change. This range represents an increase of 1.3 to 2.0 percent in costs. For consumers, per capita annual expenditures for broilers would increase from 10.1 to 15.7 cents a year. These costs represent a lower parameter of values when all substitution possibilities are ruled out of consideration. However, the same costs probably represent the upper parameter values when substitution possibilities are considered.

The upper parameter values without additive substitutes are the Situation C results. With total production reduced to 10.748 or 10.637 billion pounds depending on mortality, production costs are reduced by $6.0 or $15.5 million respectively. But consumer expenditures would rise by a maximum of $143 to $171 million annually. This result appears unrealistic since the FDA proposal does not recommend a prohibition on the use of all antibiotics as feed additives and the results in the first of this report indicate a number of close substitutes are available.

Turkeys:

This section of the report evaluates the impact of a complete ban on feeding antibiotics to turkeys without recourse to substitutes. The procedure is the same as that used for broilers except for determination of the economic effects by sex.

Assumptions:

The following are the assumptions and basic data for the analyses under Situations A, B, and C:

(1) Total turkey production in 1970 was 2.250 billion pounds from 119.681 million birds.

(2) Production in 1970 was 60.073 million hens and 59,608 million toms. Hens averaged 13.80 pounds and toms 23.839 pounds. Total hen production was 829 million pounds and tom production was 1.421 million pounds.

(3) Age at term for turkeys fed an antibiotic additive was 18 weeks (126 days) for hens and 23 weeks (161 days)for toms.

(4) The average growth rate for turkeys receiving the antibiotic was 0.7666 pounds per week (0.1095 pounds per day) for hens and 1.0365 pounds per week (0.1481 pounds per day) for toms.

(5) The average growth rate for turkeys not fed an antibiotic is 0.7422 pounds per week (0.1060 pounds per day) for hens and 1.0035 pounds per week (0.1434 pounds per day) for toms.

(6) The average feed consumption for turkeys fed an antibiotic was 42.6972 pounds per hen and 80.5043 pounds per tom. Feed conversions are 3.094 for hens and 3.377 for toms.

(7) The average feed conversion for turkeys not receiving an antibiotic is 3.258 for hens and 3.556 for toms.

(8) The average mortality is 9 percent of poult placements.

(9) The feed cost per ton with antibiotic is $81.30 for hens and $79.60 for toms.

(10) The feed cost per ton without antibiotic is $80.50 for hens and $78.80 for toms. 16/

(11) Poults cost 54 cents each.

16/ Turkey feed contains 20 grams of antibiotic per ton of feed at 4 cents a gram.

(12) The labor used for turkeys receiving antibiotic feed is 54.2 man hours per 1,000 hens and 71.3 man hours per 1,000 toms. At $2.50 per hour, the labor cost is $135.50 per 1,000 hens and $178.25 per 1,000 toms. For each additional day of production the labor input is 0.3 man hours per 1,000 birds. 17/

(13) All other costs are held constant by major cost items:

a. machinery - $ 7.00 per 1,000 hens
$ 15.00 per 1,000 toms

b. supplies - $277.00 per 1,000 birds 18/

c. fixed cost - $470.00 per 1,000 birds 19/

(14) Feed costs were derived from average costs for the 1970 feeding year developed from previous work using least-cost formulation techniques with a gross milling margin of $8 per ton and a $5 per ton delivery cost. This modification of the FDA Task Force data more nearly reflects the situation as it existed during the 1970 feeding year. 20/

Situation A:

In this situation, the same number of turkeys as were produced in 1970 are fed on a nonantibiotic feed for a longer period to achieve the same market weight as formerly. Toms are fed an additional 5 days and hens 4 days. The longer feeding period requires an additional 195,159 tons of feed. 21/

17/ Under Situation B with a 1 percent added mortality, labor costs were reduced to 40 percent of the $135.50 per thousand rate for hens and the $178.25 per thousand rate for toms. This adjustment reflects the estimated labor loss on the 1,358,437 birds occuring prior to 6 weeks of age for both sexes.

18/ Supplies include fuel, electricity, and drugs. Under Situation B with a 1 percent added mortality the ratio of $138.50 per 1,000 birds was reduced by one-half for the 1 percent added mortality group.

19/ Fixed costs includes depreciation, interest, insurance, taxes, and maintenance and repairs. Under situation B with a 1 percent added mortality, the fixed costs per 1,000 birds were reduced by 60 percent for the 1 percent added mortality group.

20/ The feed cost is less than the ton price used by FDA. This change was made following communication with Warren Trotter, Richard Russell Research Center, Athens, Georgia.

21/ See appendix table 1 for feed requirements.

This feed cost, less the 80 cent per ton antibiotic credit for feed replaced by nonadditive feed, results in a total feed cost increase of $12.549 million (table 14). The longer feeding period requires additional labor, and the increase in labor cost is $423,000 (table 14). The total increase in costs is $12.972 million or 2.7 percent.

The effect on production costs is an average increase of 0.58 cents a pound. 22/ The hen cost per pound increases by 0.56 cents and the tom cost per pound by 0.59 cents (table 15).

On a ready-to-cook (RTC) basis, the increase is 0.72 cents a pound. On an annual per capita consumption of 8.86 pounds RTC, the prohibition of antibiotic additives would increase per capita expenditures by 6 cents.

The feed consumption increase of 195,000 tons is equal to 141,000 tons in corn equivalents and 54,000 tons in soybean meal.

An increase in mortality from 9 to 10 percent would have a modest impact on costs. The remaining turkeys, 118,366 thousand, would have to be fed longer to attain the same aggregate weight. Feed consumption increases by 10,651 tons at a cost of $845,606 and labor costs increase by $145,963 (table 14). The total increase in costs is $991,569 equal to 0.04 cents a pound live and 0.05 cents a pound RTC. The increase in annual per capita expenditures is 0.5 cents.

The additional feed tonnage, 10,664 tons, is equivalent to approximately 7,800 tons of corn and 2,800 tons of soybean meal.

22/ See appendix table 2.

Table 14.--Estimated total costs for turkey production by sex with and without antibiotic feed additives under assumptions of SITUATION A

Item	Production costs		
	With antibiotics 1/	Without antibiotics 1/	Without antibiotics plus 1 percent mortality 2/
	Dollars		
Feed costs:			
Hens	104,264,084	108,710,069	109,009,719
Toms	190,989,702	199,092,347	199,638,303
Total feed cost	295,253,786	307,802,416	308,648,022
Nonfeed costs:			
Poults			
Hens	35,509,747	35,509,747	35,509,747
Toms	35,509,747	35,509,747	35,509,747
Total poults cost	71,019,494	71,019,494	71,019,494
Labor			
Hens	8,139,859	8,306,207	8,363,544
Toms	10,625,169	10,882,294	10,970,920
Total labor cost	18,765,028	19,188,501	19,334,464
Machinery			
Hens	418,292	418,292	418,292
Toms	896,341	896,341	896,341
Total machinery cost	1,314,633	1,314,633	1,314,633
Fixed costs			
Hens	28,234,160	28,234,160	28,234,160
Toms	28,015,910	28,015,910	28,015,910
Total fixed costs	56,250,070	56,250,070	56,250,070
Miscellaneous supplies			
Hens	16,640,133	16,640,133	16,640,133
Toms	16,511,504	16,511,504	16,511,504
Total miscellaneous supplies costs	33,151,637	33,151,637	33,151,637
Total nonfeed cost	180,500,862	180,924,335	181,070,298
Total cost	475,754,648	488,726,751	489,718,320

1/ 119,681,000 birds (60,072,760 hens and 59,608,240 toms) weighing 2.250 billion pounds.
2/ 118,365,750 birds (59,412,562 hens and 58,953,188 toms) weighing 2.250 billion pounds.

Table 15.-- Comparison of turkey performance, hen and tom costs with and without antibiotic feed additive under assumptions for SITUATION A

Sex	Antibiotic gram per ton	Average term liveweight	Daily gain pounds	Term length in days	Feed per bird		Nonfeed costs per bird	Total cost	
					Pounds	Cents		Per bird	Per pound liveweight
Hens----	20	13.800	0.10952	126	42.697	173.563	148.06	321.62	23.306
Toms----	20	23.839	.14807	161	80.504	320.408	153.60	474.00	19.883
Hens----	0	13.800	.10603	130.15	44.960	180.964	148.33	329.294	23.862
Toms----	0	23.839	.14336	166.29	84.772	334.001	154.03	488.031	20.472
					Difference				
Hens----	20	---	-.00349	4.15	2.263	7.401	.27	7.674	.556
Toms----	20	---	-.00471	5.29	4.268	13.593	.43	14.031	.589

Situation B:

In this situation, turkeys are raised the same length of time on nonadditive feed as on antibiotic additive feed. In order to attain the aggregate output of 2.250 billion pounds, an additional 4,326,100 poults are placed to produce 3,936,750 more mature turkeys; 1,979,375 hens and 1,957,375 toms. All turkeys average 3.184 percent less in weight on nonantibiotic feed with hens weighing 13.3598 pounds and toms 23.081 pounds at term.

An additional 195,159 tons of feed are utilized in this situation. 23/ The total increase in feed costs is $12.548 million after credit adjustment for removal of antibiotics in the feed consumed by the rest of the turkeys. (table 16).

Nonfeed costs increase for all items. Poult costs increase by $2,336,092 and labor costs increase $617,107 (table 16). Increases in the other cost centers are $43,216 for machinery, $1,090,479 for supplies, and $1,850,271 for fixed. The total nonfeed cost increase is $5,937,165 (table 16).

Total cost increases by $18.485 million or 3.9 percent. This is equivalent to an increase of 0.81 cents a pound live or 1 cent a pound RTC. 24/

23/ See appendix table 1.
24/ See appendix table 3.

Table 16.--Estimated total costs for turkey production by sex with and without antibiotic feed additives under assumptions of SITUATION B

Item	Production costs		
	With antibiotics 1/	Without antibiotics 2/	Without antibiotics plus 1 percent mortality 2/
	Dollars		
Feed costs:			
Hens	104,264,084	108,710,984	109,009,639
Toms	190,989,702	199,090,564	199,637,988
Total feed costs	295,253,786	307,801,548	308,647,627
Nonfeed costs:			
Poults			
Hens	35,509,747	36,677,793	37,085,324
Toms	35,509,747	36,677,793	37,085,324
Total poults cost	71,019,494	73,355,586	74,170,648
Labor			
Hens	8,139,859	8,407,546	8,444,503
Toms	10,625,169	10,974,589	11,022,829
Total labor cost	18,765,028	19,382,135	19,467,332
Machinery			
Hens	420,509	434,365	439,138
Toms	894,124	923,484	933,633
Total machinery cost	1,314,633	1,357,849	1,372,771
Fixed costs			
Hens	28,234,197	29,164,503	29,292,692
Toms	28,015,873	28,935,838	29,063,035
Total fixed cost	56,250,070	58,100,341	58,355,727
Miscellaneous supplies			
Hens	16,640,155	17,188,441	17,282,878
Toms	16,511,482	17,053,675	17,147,382
Total miscellaneous supplies costs	33,151,637	34,242,116	34,430,260
Total nonfeed costs	180,500,862	186,438,027	187,796,738
Total cost	475,754,648	494,239,575	496,444,365

1/ 119,681,000 birds (60,072,760 hens and 59,608,240 toms) weighing 2.250 billion pounds.
2/ 123,617,750 birds (62,052,135 hens and 61,565,610 toms) weighing 2.250 billion pounds.

Table 17.--Comparison of turkey performance, hen and tom costs with and without antibiotic feed additive under assumptions for SITUATION B

Sex	Antibiotic gram per ton	Average term liveweight	Daily gain pounds	Term length in days	Feed per bird		Nonfeed costs per bird	Total cost	
					Pounds	Cents		Per bird	Per pound liveweight
Hens-----	20	13.800	0.10952	126	42.697	173.563	148.061	321.624	23.306
Toms-----	20	23.839	.14807	161	80.504	320.408	153.60	474.008	19.884
Hens-----	0	13.3598	.10603	126	43.5262	175.190	148.057	323.247	24.195
Toms-----	0	23.0810	.14336	161	82.0760	323.379	153.600	476.979	20.665
					Difference				
Hens-----	20	-.4402	-.00349	---	.8292	1.627	-.004	1.623	.889
Toms-----	20	-.7580	-.00471	---	1.572	2.971	-0-	2.971	.781

The hen cost per pound (live) is .889 cents and the tom cost is .781 cents higher (table 17). Per capita annual expenditures increase by 9 cents.

The feed consumption increase, 195,159 tons is equivalent to 141,000 tons of corn and 54,000 tons of soybean meal.

An increase in mortality from 9 to 10 percent requires starting an additional 1,509,375 poults to realize the same aggregate weight. Feed consumption increases by 10,657 tons at a cost of $846,079. Nonfeed costs increase by $815,062 for poults, $85,197 for labor, $14,922 for machinery, $188,144 for supplies and $255,386 for fixed (table 16).

The 1 percent increase in mortality increases total cost by $2.205 million (table 16). This is equivalent to 0.10 cents per pound live or 0.12 cents a pound RTC. The effect on annual per capita expenditures is about one cent.

The feed tonnage increase is equal to 7,800 tons of corn and 2,800 tons of soybean meal.

Situation C:

In this situation, the same number of turkeys are raised the same length of time as turkeys on antibiotic feed. The difference is a reduction in output of 71.627 million pounds (live). The effect of this decrease in output is a change in the price and revenue received by producers as well as costs.

Although turkey output is less, consumption of the non-antibiotic feed is higher by 71,743 tons. [25] The net increase in feed costs is $2.750 million (table 18). Labor costs for handling the additional feed increase by $45,000. (1 man hour per 4 tons of feed). Total production costs increase by $2.795 million. Production costs are increased by 0.892 cents a pound for hens and 0.783 cents a pound for toms (table 19).

The change in the farm price for turkeys is estimated from the following equation. [26]

$$\%\Delta P_t = -.427Q_b - .686Q_p - .540Q_c - 1.620Q_t$$

where:

Beef $(Q_b) = -2.052\%$

Pork $(Q_p) = -9.428\%$

Broilers $(Q_c) = -2.244\%$

Turkeys $(Q_t) = -3.184\%$

The increase in the turkey farm price is 13.71 percent. In 1970, the average farm price for turkey was 22.6 cents a pound. The new estimated price is 25.7 cents a pound, a 3.1 cent increase. Total farm receipts in 1970 were $508.500 million and the higher price increases sales receipts to $559.817 million, an increase of $51.317 million (App. Table 4). The net increase in revenue to producers is $48,522 mil-

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[25] See appendix table 1.

[26] Paulsen, A. 1970, Economic impact of restricting antibiotic additives in swine feeding. Journal paper of the Iowa Agricultural Experiment Station. For detailed reference see literature citations.

Table 18.--Estimated total costs for turkey production by sex with and without antibiotic feed additives under assumptions of SITUATION C

Item	Production costs		
	With antibiotics 1/	Without antibiotics 2/	Without antibiotics plus 1 percent mortality 3/
	Dollars		
Feed costs:			
Hens	104,264,084	105,243,205	104,375,817
Toms	190,989,702	192,760,796	191,172,109
Total feed costs	295,253,786	298,004,001	295,547,926
Nonfeed costs:			
Poults			
Hens	35,509,747	35,509,747	35,509,747
Toms	35,509,747	35,509,747	35,509,747
Total poults cost	71,019,494	71,019,494	71,019,494
Labor			
Hens	8,139,859	8,159,379	8,150,992
Toms	10,625,169	10,650,649	10,639,701
Total labor cost	18,765,028	18,810,028	18,790,693
Machinery			
Hens	420,509	420,509	420,509
Toms	894,124	894,124	894,124
Total machinery cost	1,314,633	1,314,633	1,314,633
Fixed costs			
Hens	28,234,197	28,234,197	28,234,197
Toms	28,015,873	28,015,873	28,015,873
Total fixed cost	56,250,070	56,250,070	56,250,070
Miscellaneous supplies			
Hens	16,640,155	16,640,155	16,640,155
Toms	16,511,482	16,511,482	16,511,482
Total miscellaneous supplies costs	33,151,637	33,151,637	33,151,637
Total nonfeed costs	180,500,862	180,545,862	180,526,527
Total costs	475,754,648	478,549,863	476,074,453

1/ 119,681,000 birds (60,072,760 hens and 59,608,240 toms) weighing 2.250 billion pounds.
2/ 119,681,000 birds (60,072,760 hens and 59,608,240 toms) weighing 2.178 billion pounds.
3/ 118,366,000 birds (59,406,712 hens and 58,959,288 toms) weighing 2.154 billion pounds.

Table 19.--Comparison of turkey performance, hen and tom costs with and without antibiotic feed additives under assumptions for SITUATION C

Sex	Antibiotic gram per ton	Average term liveweight	Daily gain pounds	Term length in days	Feed per bird		Nonfeed costs per bird	Total cost	
					Pounds	Cents		Per bird	Per pound liveweight
Hens----	20	13.800	0.10952	126	42.697	173.563	148.061	321.624	23.306
Toms----	20	23.839	.14807	161	80.504	320.408	153.596	474.004	19.884
Hens----	0	13.3598	.10603	126	43.5262	175.193	148.093	323.286	24.198
Toms----	0	23.0810	.14336	161	82.0760	323.379	153.639	477.018	20.667
					Difference				
Hens----	20	-.4402	-.00349	---	.8292	1.630	.032	1.662	.892
Toms----	20	-.7580	-.00471	---	1.5720	2.971	.043	3.014	.783

lion, because feed costs and labor increase by $2.795 million. 27/

For consumers, the price increase is 3.9 cents a pound RTC. Per capita annual expenditures increase by 25.2 cents a year and per capita annual consumption is .28 pounds RTC less.

An increase in mortality from 9 to 10 percent reduces turkey output by 24 million pounds to 2.154 billion, a further decrease of 1.1 percent. Production costs decrease by $2.475 million, $2.456 million of the decrease is for a reduction in feed consumption of 30,936 tons (table 18). The balance of the reduction is for reduced labor inputs. There is the possibility of minor cost reductions for machinery and supplies, but these are not considered here.

The increased mortality results in a further increase in turkey prices. Using the equation above and quantity change coefficients adjusted for increased mortality, the turkey price increase is 16.86 percent, 3.15 percent higher than the case with feed without antibiotic and no change in mortality. The adjusted quantity change coefficients are:

Beef (Q_b) = - 2.691%

Pork (Q_p) = - 10.318%

Broilers (Q_b) = - 3.247%

Turkeys (Q_t) = - 4.247%

The farm price of turkey with the 10 percent mortality is 26.41 cents a pound live, an increase of 0.71 cents a pound. Total

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27/ See appendix table 4.

producer revenue is $568.989 million, an increase of $9.172 million (appendix table 4). With the reduction in production costs, net revenue increases by $11.647 million.

The price effect from the additional mortality and output reduction would increase per capita annual expenditures by 4.5 cents. Per capita consumption decreases by another 0.09 pounds RTC. The RTC price increases by 0.90 cents a pound.

In conclusion, maintaining turkey output at 2.250 billion pounds without use of antibiotic feed additives and no mortality change would increase production costs between $12.972 and $18.485 million, or 2.7 to 3.9 percent. Per capita annual expenditures would increase between 6.4 and 9.1 cents. Increased mortality of 1 percent would have a modest effect on costs of $1.0 to $2.2 million annually.

A reduction of 3.2 percent in turkey output along with reductions in supply of beef, pork, and broilers would increase the turkey price by 3.1 cents a pound and boost net revenue to producers by $48.522 million. Consumer expenditures increase by $51.317 million or 25.3 cents per capita. Increasing mortality by 1 percent would increase producer net revenues by another $11.647 million. Price is increased by 2.8 percent to 26.41 cents a pound. Consumer expenditures increase by $9.343 million or 4.5 cents per capita.

Appendix table 1.--Feed consumption for broilers and turkeys under Situations A, B, and C

Situation	Poultry	Feed consumption		
		No change in mortality		Change in mortality
		With antibiotic	Without antibiotic	Without antibiotic
		Tons		
A	Broilers	11,977,413	12,213,235	12,244,708
	Turkeys	3,681,829	3,876,988	3,887,639
	Total	15,659,242	16,090,223	16,132,348
B	Broilers	11,977,413	12,213,235	12,244,712
	Turkeys	3,681,829	3,876,977	3,887,634
	Total	15,659,242	16,090,212	16,132,246
C	Broilers	11,977,413	11,939,749	11,847,432
	Turkeys	3,681,829	3,753,572	3,722,636
	Total	15,659,242	15,697,090	15,570,069

Appendix table 2.--SITUATION A: Estimated effects of adjusting to a ban on the use of antibiotic feed additives by feeding the same number of birds as were fed before the ban for longer feeding periods to maintain output.

Item	Unit	Broilers	Turkeys	Total
	Zero change in mortality as a result of ban			
Increase in feed costs 1/	Mil. dol.	16.211	12.549	28.760
Increase in nonfeed costs	Mil. dol.	4.398	.423	4.821
Total increase in costs	Mil. dol.	20.609	12.972	33.581
Per capita increase in costs	Dollars	.10	.06	.16
Increase in cost per pound liveweight	Cents	.19	.58	.25
Increase in cost per pound retail weight	Cents	.26	.72	.34
Increase in feed usage				
Total	Thous. tons	236	195	431
Corn equivalent	Thous. tons	171	141	312
Soybean oil meal equivalent	Thous. tons	65	54	119
	Additional effect of each 1 percent increase in mortality			
Increase in feed costs 1/	Mil. dol.	2.483	.846	3.329
Increase in nonfeed costs	Mil. dol.	---	.146	.146
Total increase in costs	Mil. dol.	2.483	.992	3.475
Per capita increase in costs	Dollars	.01	.005	.015
Increase in costs per pound liveweight	Cents	.02	.04	.02
Increase in costs per pound retail weight	Cents	.03	.05	.03
Increase in feed usage				
Total	Thous. tons	31	11	44
Corn equivalent	Thous. tons	22	8	32
Soybean oil meal equivalent	Thous. tons	9	3	12

1/ Amount by which cost of nonantibiotic feed exceeds the cost of feed and antibiotic feed additives used to produce 1970 level of output.

Appendix table 3.--SITUATION B: Estimated effects of adjusting to a ban on the use of antibiotic feed additives by feeding greater numbers of birds as were fed before the ban for the same pre-ban feeding periods to maintain output.

Item	Unit	Broilers	Turkeys	Total
	Zero change in mortality as a result of ban			
Increase in feed costs	Mil. dol.	16.211	12.548	28.839
Increase in nonfeed costs	Mil. dol.	4.398	3.601	7.999
Increase in chick or poult costs	Mil. dol.	6.020	2.336	8.356
Total increase in cost	Mil. dol.	26.629	18.485	45.114
Per capita increase in costs	Dollars	.13	.09	.22
Increase in costs per pound liveweight	Cents	.24	.81	.34
Increase in costs per pound retail weight	Cents	.33	1.00	.45
Increase in feed usage				
Total	Thous. tons	236	195	431
Corn equivalent	Thous. tons	171	141	312
Soybean oil meal equivalent	Thous. tons	65	54	119
	Additional effect in each 1 percent increase in mortality			
Increase in feed costs	Mil. dol.	2.483	.846	3.329
Increase in nonfeed costs	Mil. dol.	---	.544	.544
Increase in chick or poult costs	Mil. dol.	2.800	.815	3.615
Total increase in cost	Mil. dol.	5.283	2.205	7.488
Per capita increase in costs	Dollars	.03	.01	.04
Increase in costs per pound liveweight	Cents	.05	.10	.06
Increase in costs per pound retail weight	Cents	.07	.12	.08
Increase in feed usage				
Total	Thous. tons	31	11	42
Corn equivalent	Thous. tons	22	8	30
Soybean oil meal equivalent	Thous. tons	9	3	12

Appendix table 4.--SITUATION C: Estimated effects of adjusting to a ban on the use of antibiotic feed additives by feeding the same number of birds as were fed before the ban for the same feeding periods with decline in output

Item	Unit	Broilers	Turkeys	Total
	Zero Change in Mortality as a Result of Ban			
Producer Value Changes				
Increase in sales receipts	Mil. dol.	143.350	51.317	194.667
Reduction in feed and nonfeed costs	Mil. dol.	5.992	(2.795)	3.197
Total increase in net revenue	Mil. dol.	149.342	48.522	197.864
Increase in liveweight selling price per pound	Cents	1.67	3.10	1.91
Reduction in feed usage :				
Total	Thous. tons	38	(-72)	(-34)
Corn equivalent	Thous. tons	27	(-53)	(-25)
Soybean oil meal equivalent	Thous. tons	11	(-19)	(- 9)
Consumer Effects				
Total increase in expenditures	Mil. dol.	143.350	51.317	194.667
Per capita increase in expenditures	dol.	.71	.25	.96
Increase in consumer prices at retail	Cents/lb. RTC	2.88	3.88	2.57
Reduction in per capita consumption	Pounds RTC	.88	.28	1.17
	Additional Effects of Each 1 Percent Increase in Mortality			
Producer Value Changes				
Increase in sales receipts	Mil. dol.	27.286	9.172	36.458
Reduction in feed costs	Mil. dol.	7.283	2.456	9.739
Reduction in nonfeed costs	Mil. dol.	2.260	.019	2.279
Total increase in net revenue	Mil. dol.	36.829	11.647	48.476
Increase in liveweight selling price per pound	Cents	.42	.71	.47
Reduction in feed usage :				
Total	Thous. tons	92	31	123
Corn equivalent	Thous. tons	67	22	89
Soybean oil meal equivalent	Thous. tons	25	9	34
Consumer Effects				
Total increase in expenditures	Mil. dol.	27.286	9.172	36.458
Per capita increase in expenditures	dol.	.134	.045	.180
Increase in consumer prices at retail weight	Cents/lb.	.35	.54	.39
Reduction in per capita consumption	Pounds RTC	.58	.89	.62

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